

Netlander Positioning with the Mars Infrastructure Constellation and Its Impact on Martian Geodesy

Sien Wu, Yoaz Bar-Sever, Sumita Nandi, Larry Romans



Jet Propulsion Laboratory
California Institute of Technology



Introduction to Netlander

- Mars geodetic science experiment
- Year 2006–2008
- 4 Mars landers with 10^3 km spread
- Clock stability: 10^{-11} over 60 sec
- Nominal tracking:
 - with Mars Express (6-hr elliptical orbiter)
 - 0.5-mm/sec doppler
 - 3 hours per week over 1 Martian year



Mars Infrastructure's Microsat Candidate Orbits

Launch	ID	inclination	altitude	
2003	M1	172°	800 km	
2005	M2	172°	800 km	
	M3	111°	800 km	
2007	M4	172°	800 km	replaces M1
	M5	111°	800 km	
2009	M6	111°	800 km	
	M7	111°	800 km	



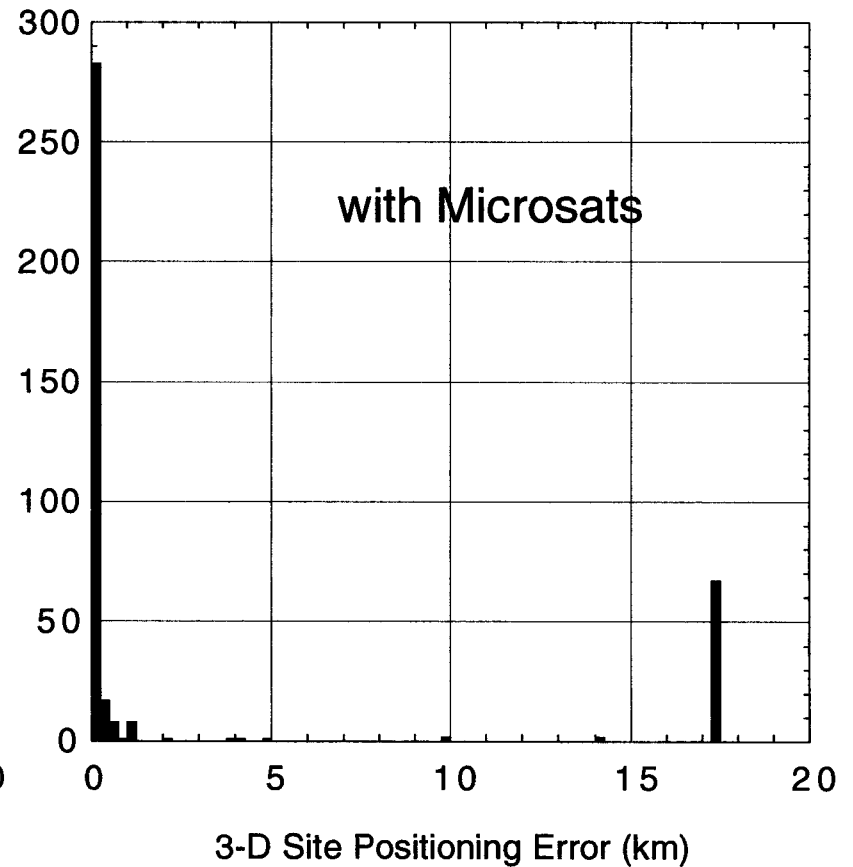
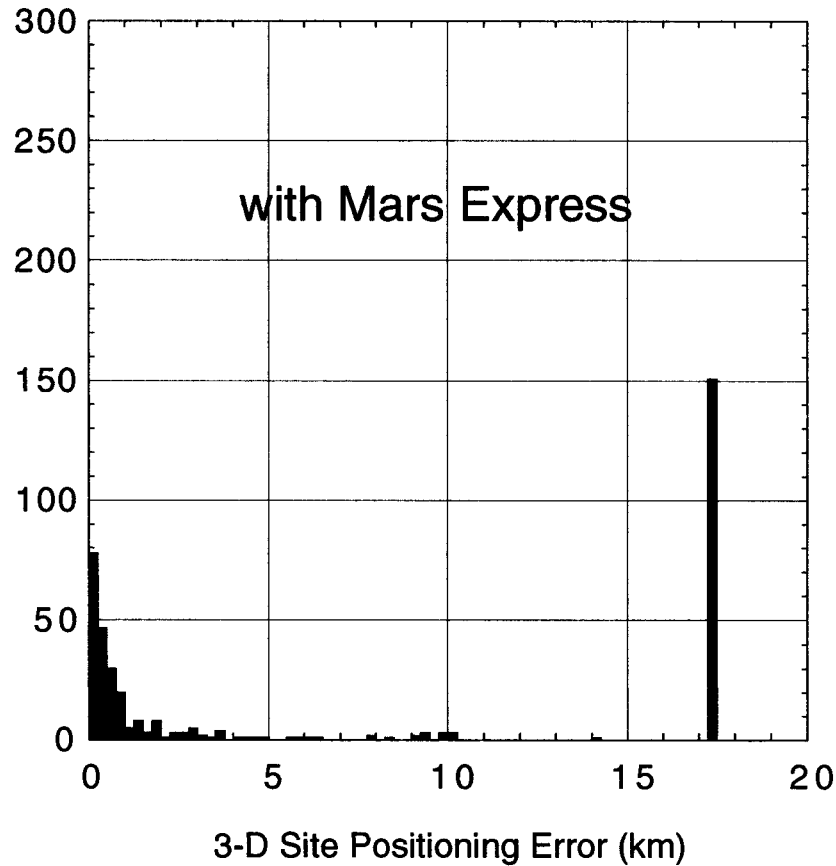
Estimation Scenario

- Data
 - data type: 1-way or 2-way doppler
 - data quality: 0.5 mm/sec
 - data interval: 60 sec
 - data passes: one 3-hr pass per week
 - data span: 98 passes
- Estimated parameters
 - X, Y, Z of Netlander site locations
 - 24 Mars rotation parameters
 - random-walk Netlander clock drifts (1-way doppler only)



Netlander Positioning Formal Error (no Mars Rotation Parameters Estimated)

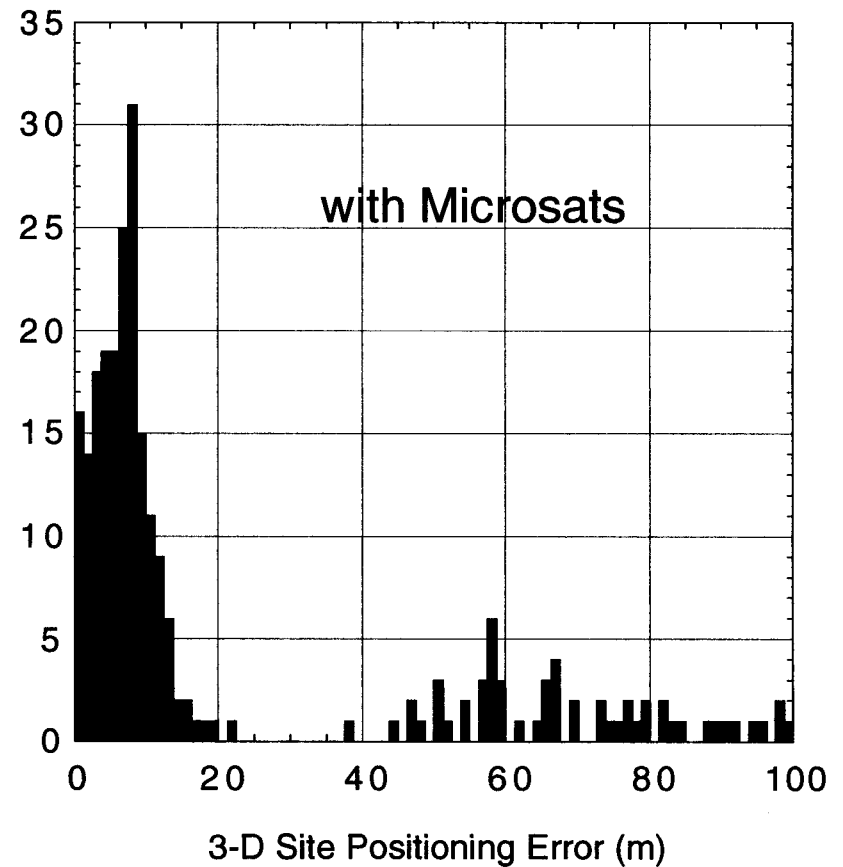
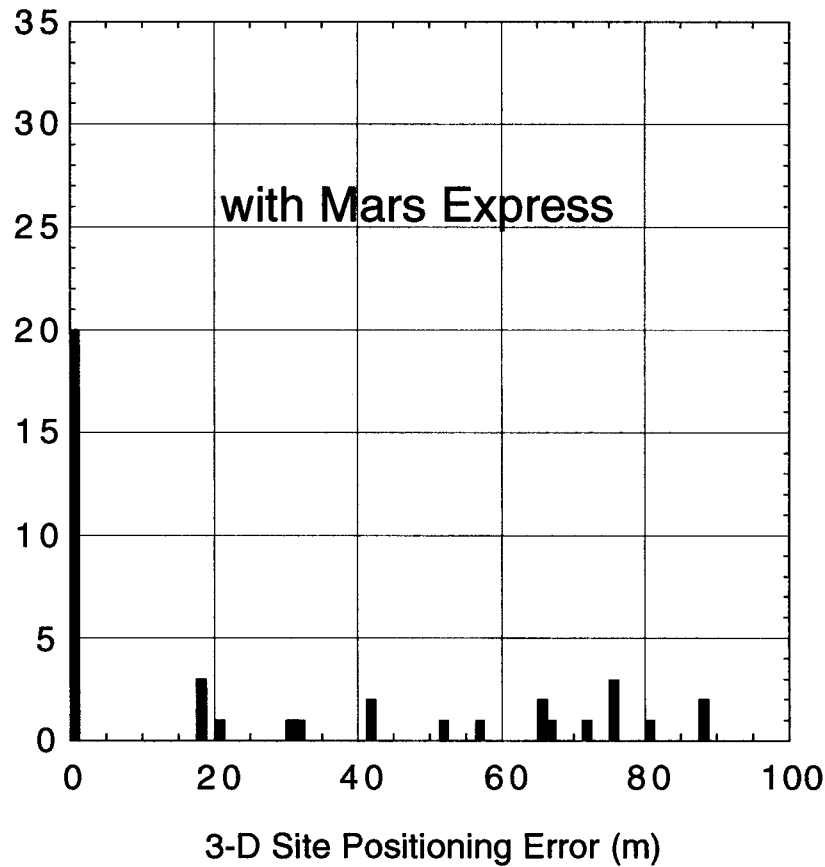
1-way doppler over 3 hours (histogram over 98 passes)





Netlander Positioning Formal Error (no Mars Rotation Parameters Estimated)

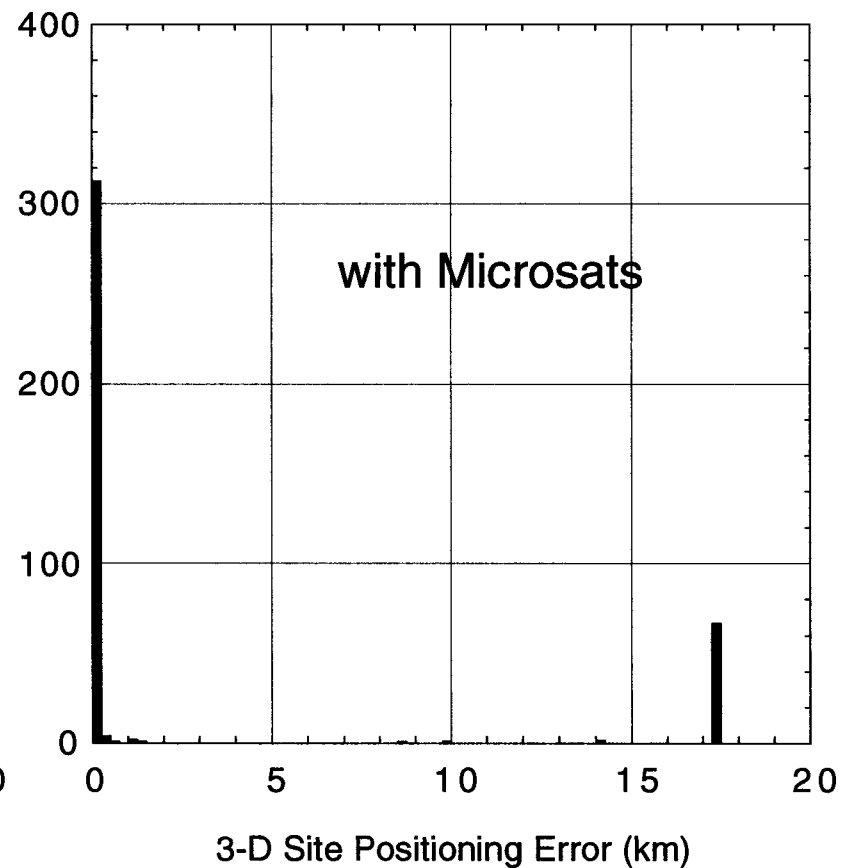
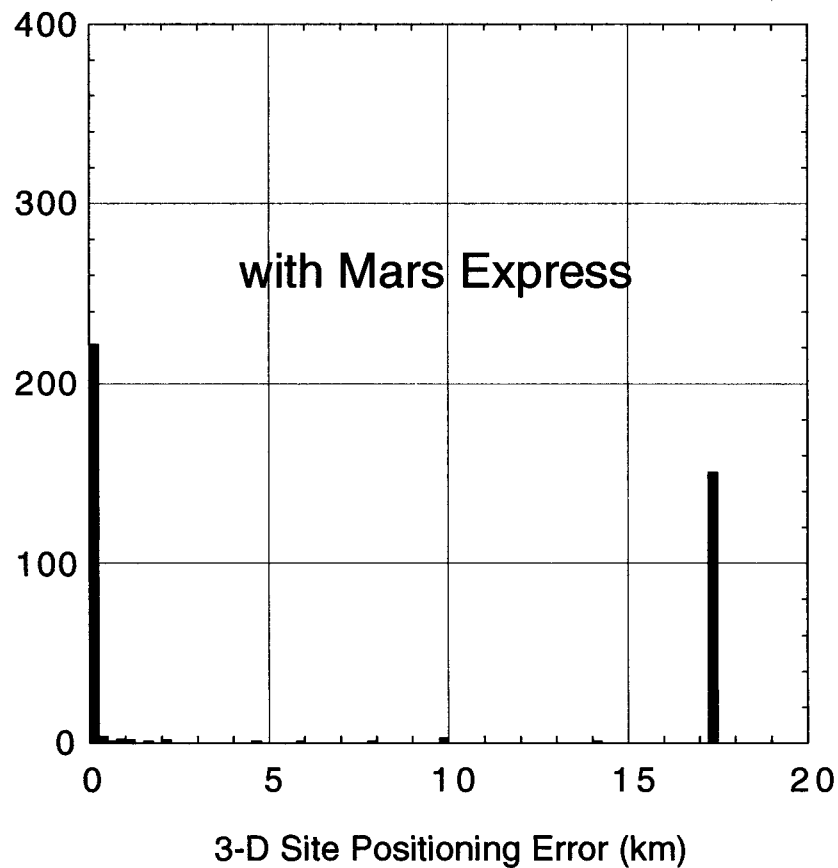
1-way doppler over 3 hours (histogram over 98 passes)





Netlander Positioning Formal Error (no Mars Rotation Parameters Estimated)

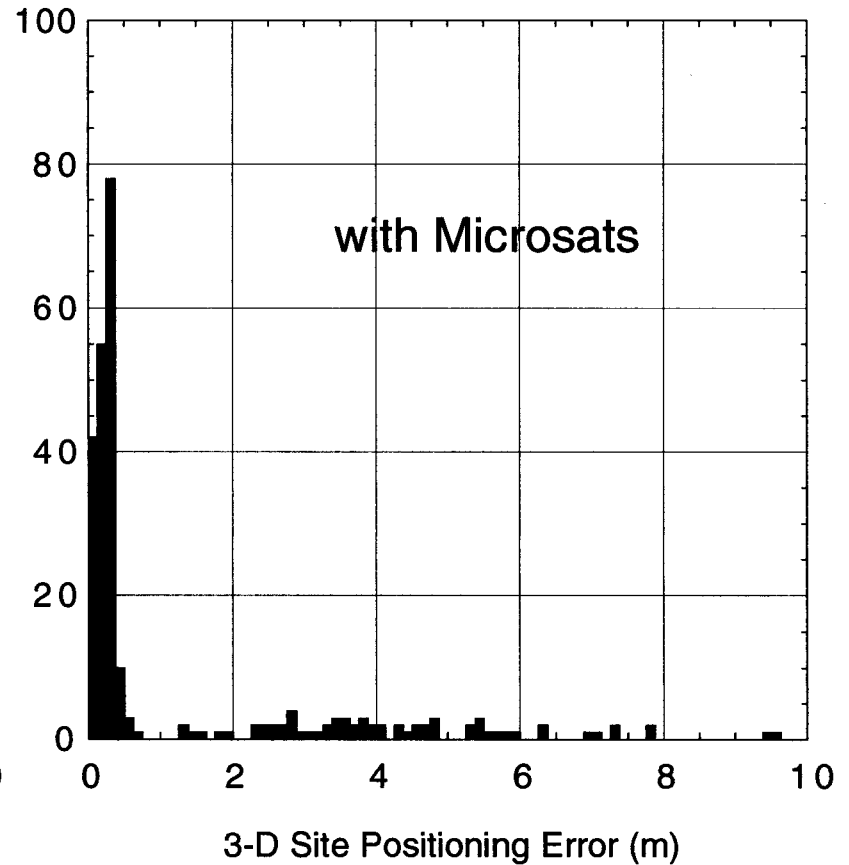
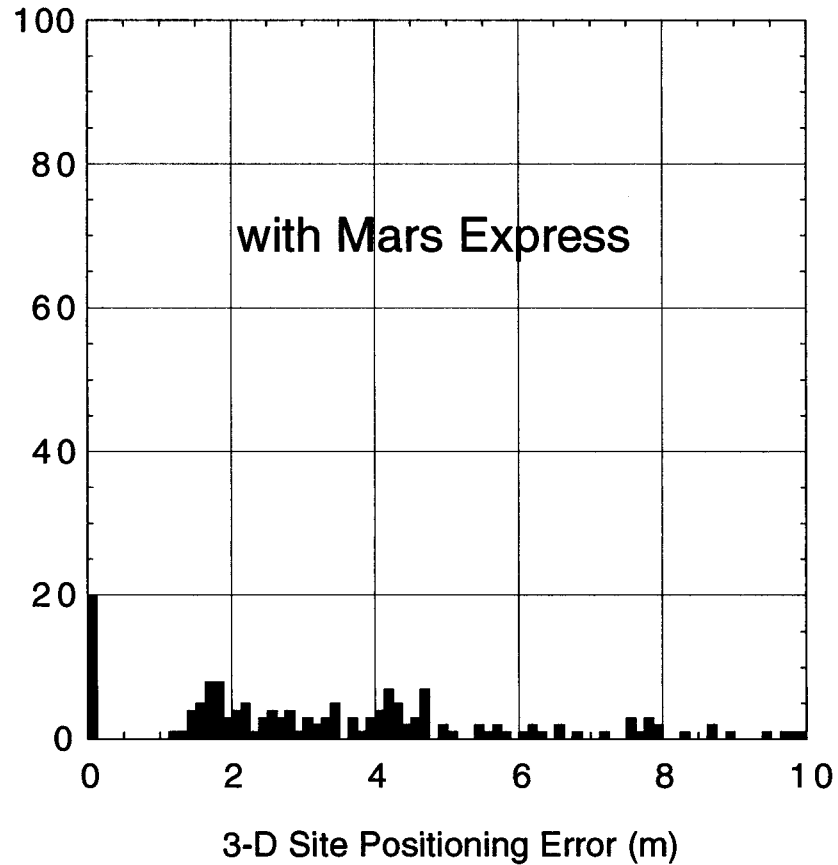
2-way doppler over 3 hours (histogram over 98 passes)





Netlander Positioning Formal Error (no Mars Rotation Parameters Estimated)

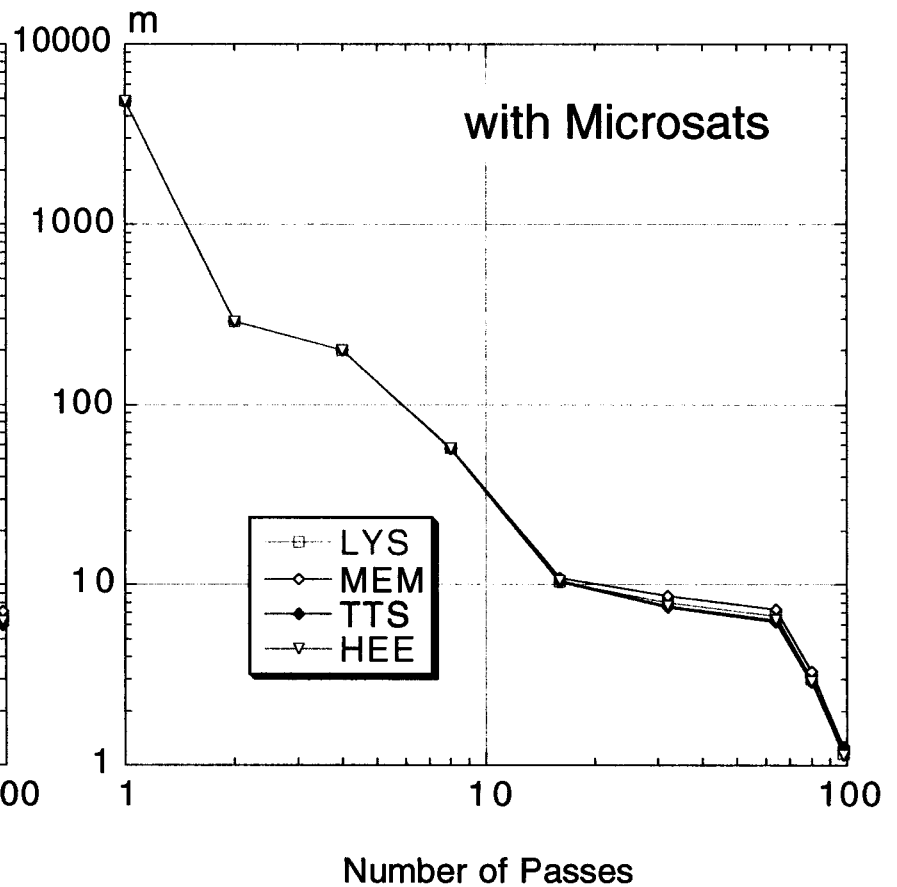
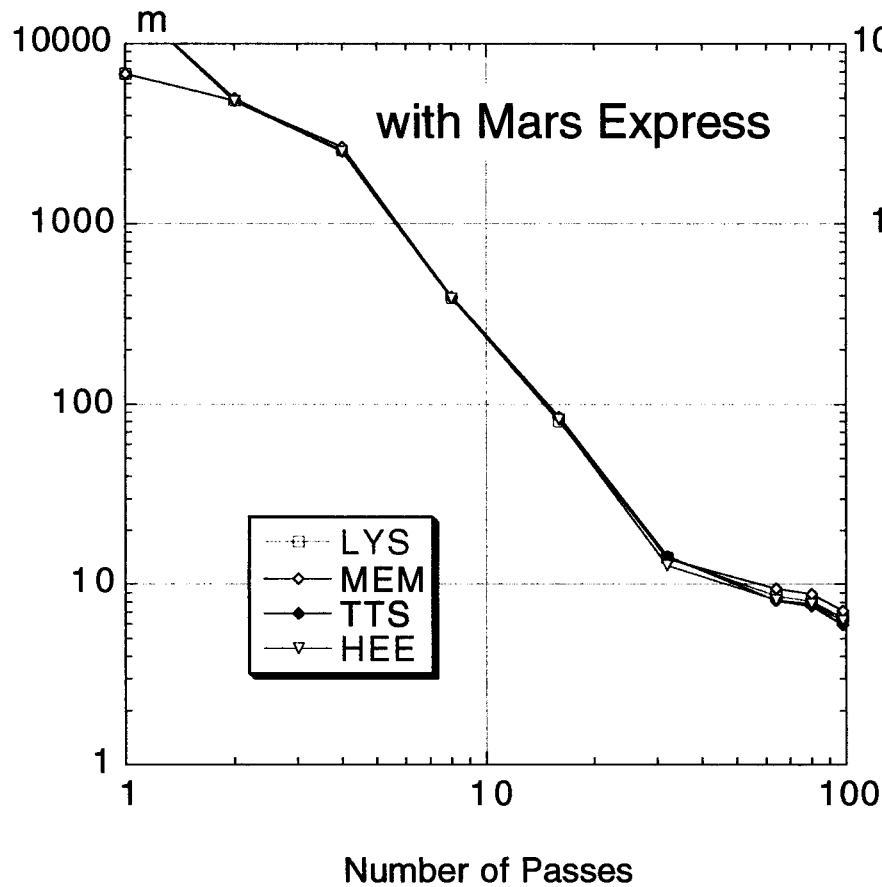
2-way doppler over 3 hours (histogram over 98 passes)





Netlander Positioning Formal Error (24 Mars Rotation Parameters Estimated)

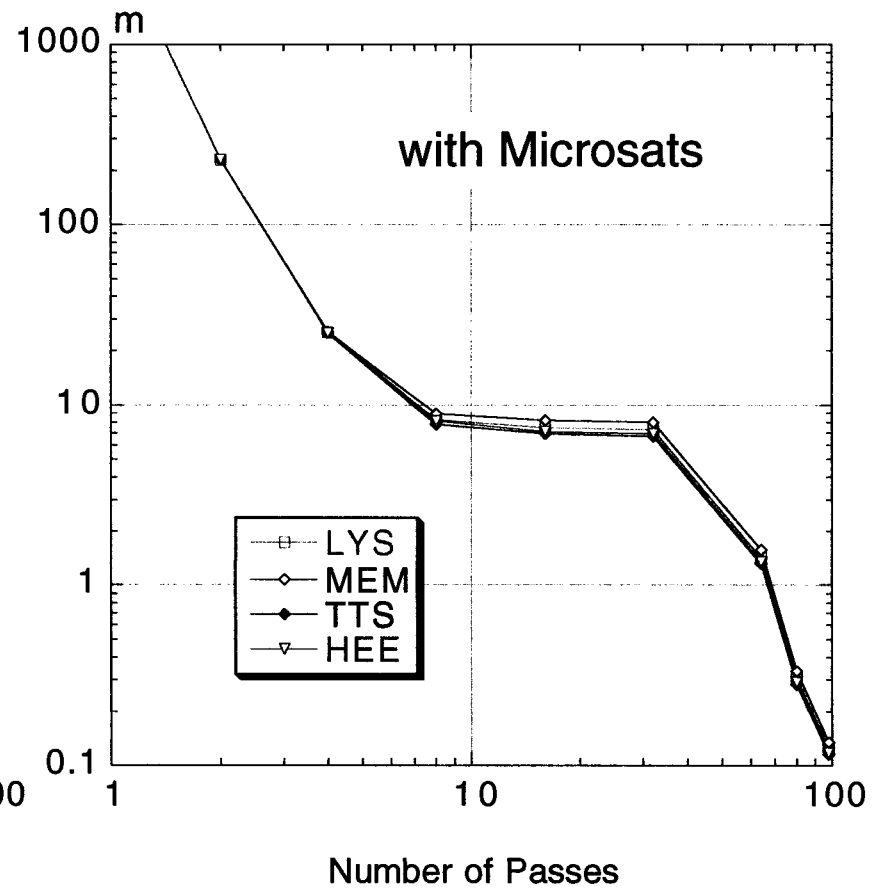
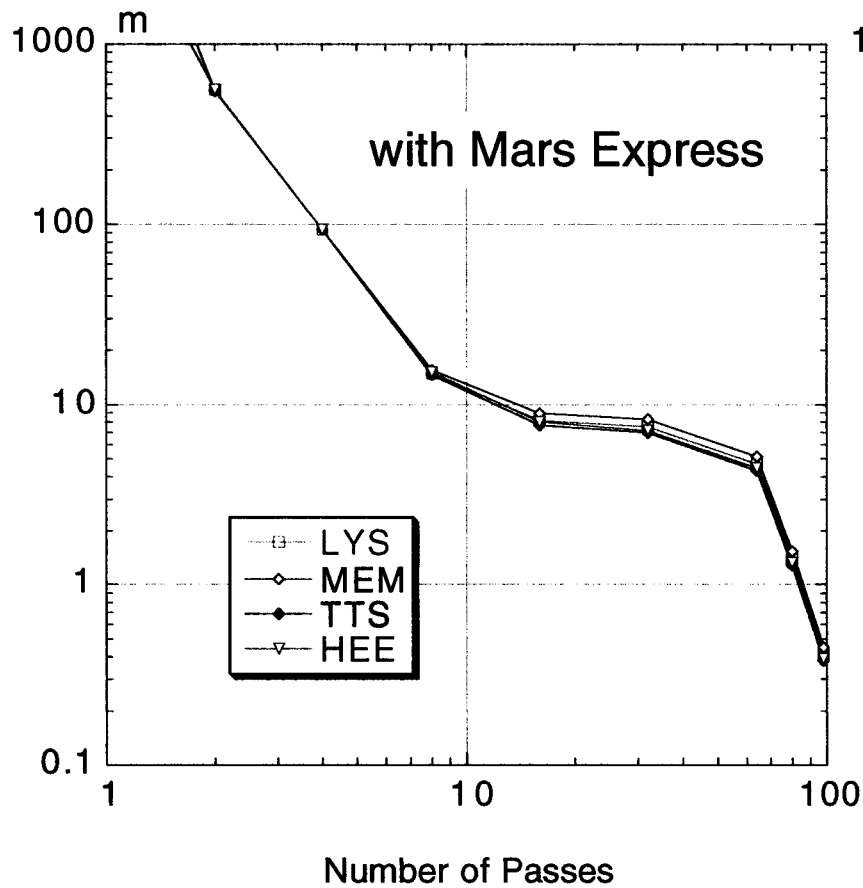
one 3-hr pass of 1-way doppler per week





Netlander Positioning Formal Error (24 Mars Rotation Parameters Estimated)

one 3-hr pass of 2-way doppler per week





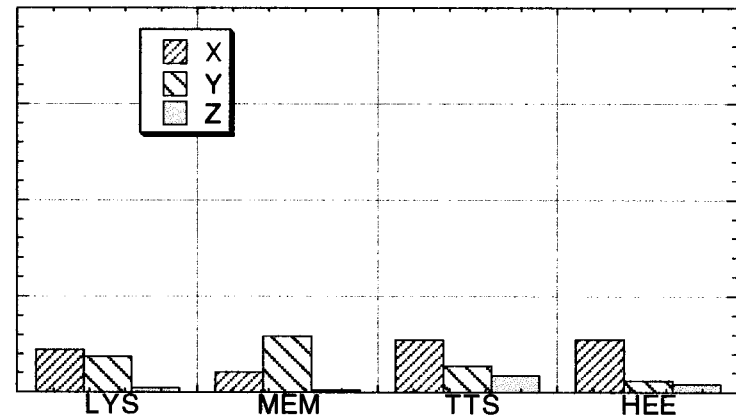
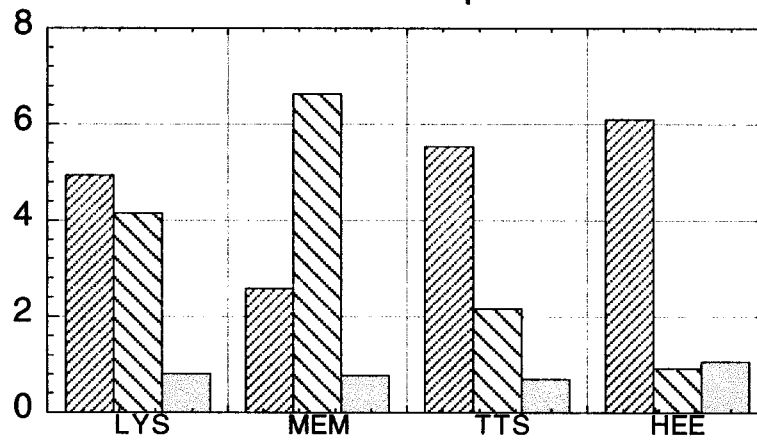
Netlander Positioning Formal Error (24 Mars Rotation Parameters Estimated)

one 3-hr pass per week for 1 Martian year

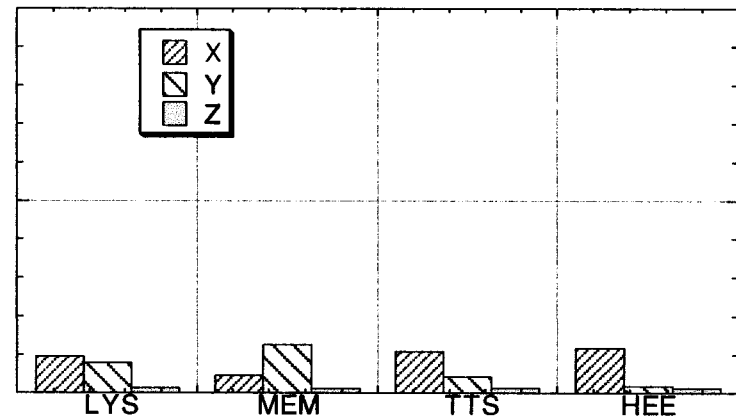
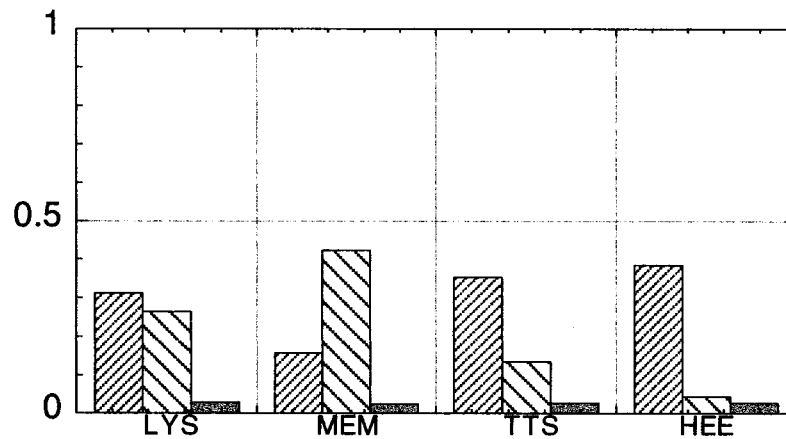
with Mars Express

with Microsats

1-way
doppler



2-way
doppler

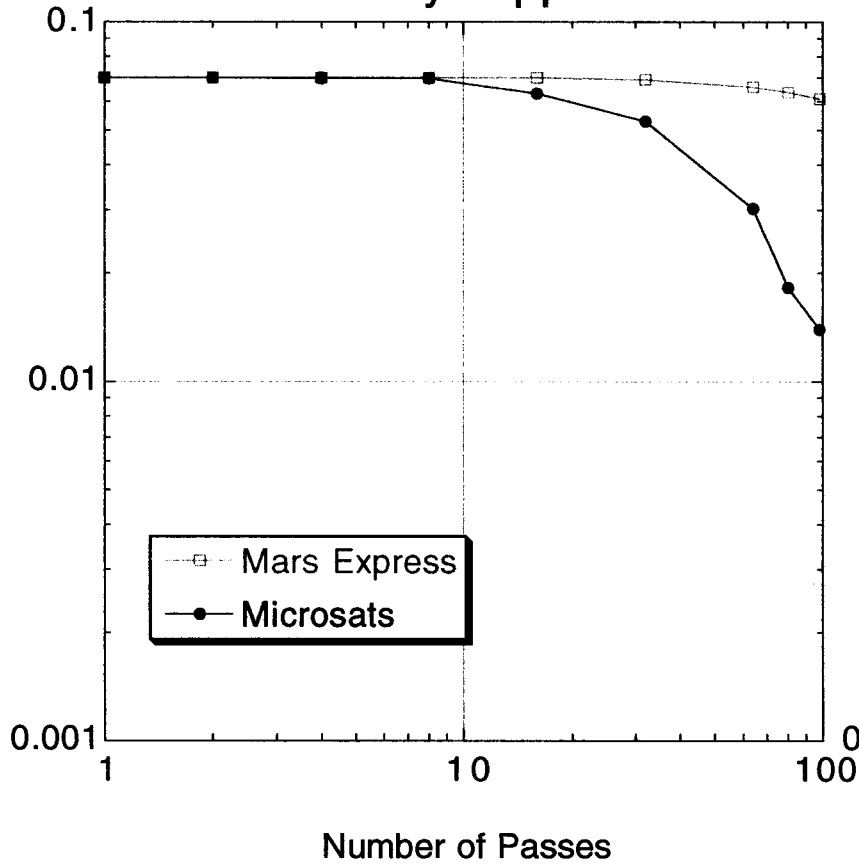




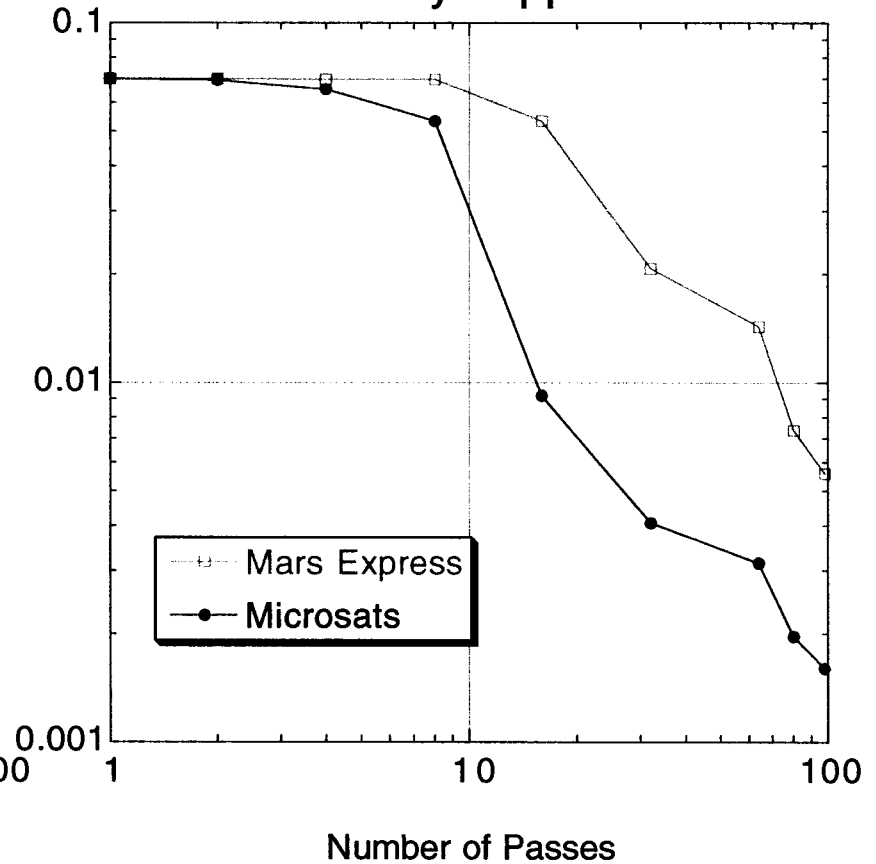
Mars Core Moment Factor Determination Error

one 3-hr measurement pass per week for 1 Martian year

1-way doppler



2-way doppler



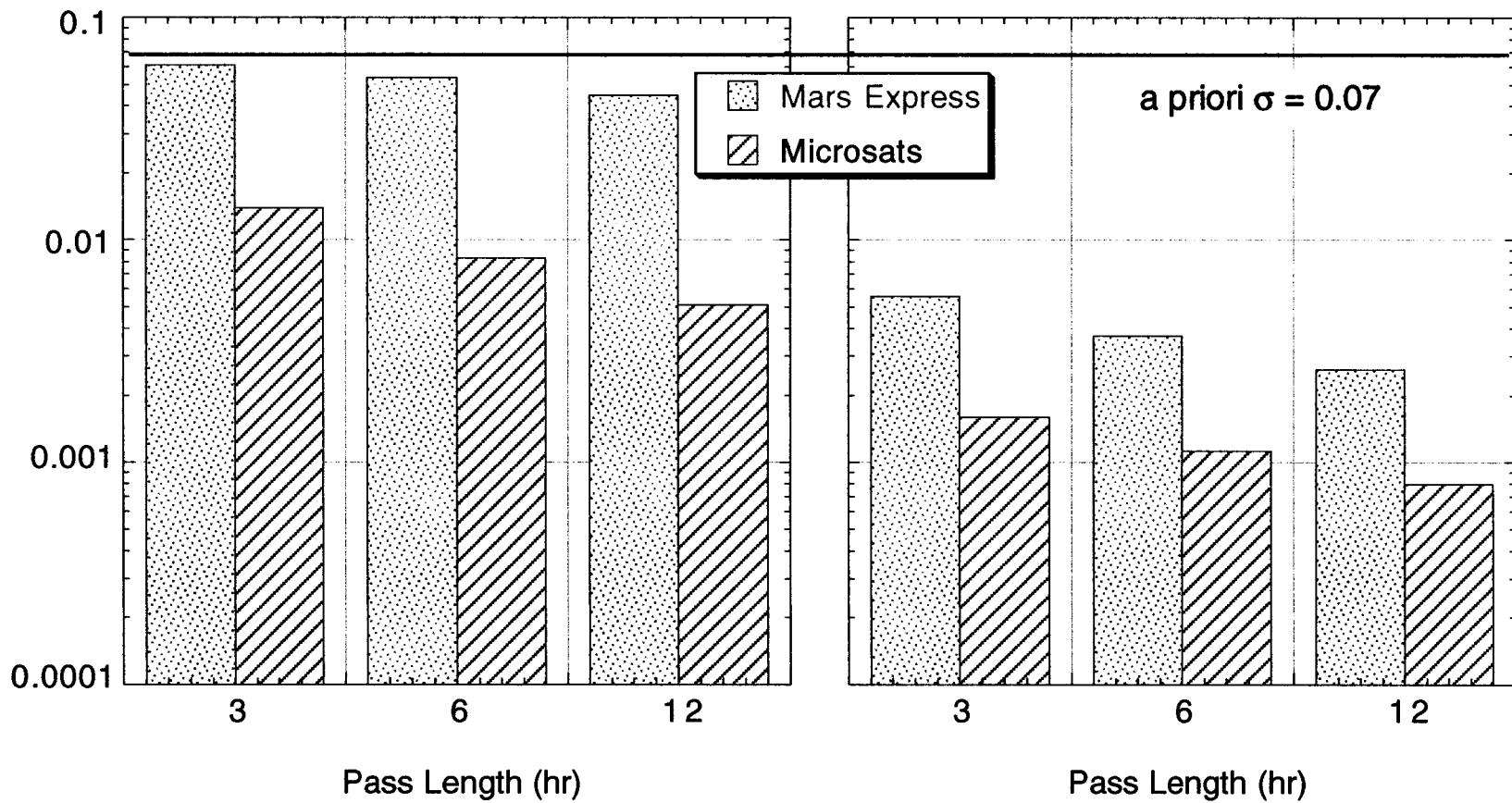


Mars Core Moment Factor Determination Error

one pass per week for 1 Martian year

1-way doppler

2-way doppler





Summary

- Mars Infrastructure's Microsats strengthen (over Mars Express) estimation of
 - Netlander site position by a factor of 4–5
 - Mars rotation parameters by a factor of 3–4
- Improvement of Mars long-term rotation parameters by 2 orders of magnitude is possible
- Other errors to be investigated
 - orbit errors (including Mars gravity)
 - ionospheric delay